University of Pittsburgh
LEARNING RESEARCH AND DEVELOPMENT CENTER

March 30, 1992

Scientific Officer Code: 1142CS
Dr. Susan E. Chipman
Office of Naval Research
800 N. Quincy St.
Arlington, VA 22217-5000

Dear Susan;

This letter is a quarterly progress report for the On-Line Assessment of Expertise project (Grant N00014-91-J-1532). It covers the period from January, 1992 to March, 1992.

The major accomplishment during the report period was designing 3 studies and running one of them.

The initial study was designed to test the user interface for gathering data about problem solving, test our choice of problems, and gather verbal protocols that could be compared to the user-interface action sequences collected by the system. Ten subjects were drawn from the Pitt intro physics class for science and engineering majors. Each subject was first introduced to the system and taught how to use the editors to solve problems. They were also shown how to call up any of the ten example from their textbook and read it via the poor-man's eyetracker. They then solved problems relevant to the target chapter (chapter 5 -- Newton's laws applied to translational motion without friction) but taken from other textbooks. They worked for two hours, solving as many problems as they could. They were asked to give a verbal protocol as they worked, and prompted when they fell silent. The first five subjects uncovered significant problems with the user interface, so their runs were truncated and/or protocols were not taken. They helped us improve the interface to the point where subjects now find it simple to learn and use, but their data has been discarded. Subsequent analysis will be based on the five remaining subjects.

The second study will begin running this week. The second study is designed to test the user interfaces for various kinds of qualitative problem solving: The problem classification task, stating a basic approach, estimating difficulty and McClosky-style conceptual problem solving. We plan on running ten subjects, and expect the first five to be used only as pilots to debug the interfaces.

The third study will be conducted during the Pitt summer session. The timing is crucial. We

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plan to catch physics students just before they are ready to read Chapter 5, then have them make their first reading of the chapter using Olae's poor-man's eyetracker to read the examples. We hope to detect self-explanation from the latency data. We will collect verbal protocols on half the problems, and score these in the usual way in order to determine where the student is self-explaining. The latency data will, we hope, correlate strongly with the verbal data. Moreover, the distribution of latencies should be similar on the problems were verbal protocols were not given.

Now that we have some problem solving data, we have begun developing a technique for matching the actions gather from the user interface to the lines of reasoning generated by Cascade and embedded in the Bayesian networks. This appears to be a very difficult problem, and may require some significant representational changes in Cascade (currently, it does not distinguish mental actions from physical actions. If it did, then we would have a much easier time matching its predictions to the data, which consist of physical actions only).

As part of a formative evaluation of Olae, we plan on comparing our interpretation of the verbal protocols to the interpretation of the action protocols derived by Olae. However, we do not have the money to hire a transcriptionist for the verbal protocols, nor the patience to do it ourselves, so we have begun to looking into hooking up some digital audio technology to Olae so that when we replay the action sequences, it will also replay the verbal protocol that occurred in the vicinity of the current action. We are aware of the poor track record of attempts to work around the transcription bottleneck, but there is this new digital speech compression technology that could potentially be used, so we feel that it is worth a few days work to evaluate the feasibility. It could save us a great deal of time in the long run if it works.

In January, two graduate students associated with the project began working on individual projects aimed at building models to help us interpret the qualitative data. Jonathan Rubin is building a model of solution planning that we hope will allow us to model three tasks: the classification task, the stating of a basic approach to a quantitative problem, and the estimation of a quantitative problem's difficulty. Progress during the first two months was unexpectedly rapid. Jon found that some small changes to Cascade sufficed to have it create a solution plan and run it. During the last month, however, things have slowed down as we try to debug the system and get it to run on more problems. .

Sigalit Ur is doing a master thesis (which is required of all our PhD students) on conceptual problem solving and conceptual change. She is building on top of work done by Rolf Ploetzner, a graduate student who visited my group last year and wrote an initial version of a conceptual problem solver based on Cascade. Sigalit began by collecting protocols from 4 subjects as they solved conceptual problems. She found the usual menagerie of misconceptions, and got some ideas of the chronology of the process. In particular, she found subjects would often produce their answer quickly, but when pressed to justify it, would come up with all kinds of wonderful recollections (cases), imagery and p-prim-filled reasoning. Sigalit and I have had an intensive series of meetings with Micki Chi and her student, Jim Slotta, who are working on conceptual shifts in physics and biology. We have also been corresponding with Andy di Sessa and Jeremy Roschelle over the net. We're trying to bring all these various intuitions and empirical generalizations together and to operationalize them in a conceptual problem solver. This should help us understand how to interpret the data from Olae's conceptual problem solving

task as well as setting the stage for further work on models of conceptual change.

Sincerely,

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Statement A per telecon
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